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10AE73

Seventh Semester B.E. Degree Examination, June/July 2019
Aircraft Stability and Control

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define longitudinal static stability and derive an expression for tail contribution ($C_{m_{\alpha_t}}$) for the static longitudinal stability of an airplane. **(10 Marks)**

b. For the given general aviation airplane data, determine the contribution of the wing and tail to the C_m versus α curve. Assume standard sea-level atmospheric conditions.

$W = 2750$ N, $V = 176$ m/s, $X_{cg} = 0.295\ \bar{c}$

Wing airfoil characteristics	Tail airfoil section
$C_{m_{ac}} = -0.116$	$C_{\ell_\alpha} = 0.01$/deg
$C_{\ell_\alpha} = 0.097$/deg	$C_{m_{ac}} = 0.0$
$\alpha_{O_L} = -5°$	$i_t = -1.0°$
$x_{ac} = 0.25\,\bar{c}$	$C_{L_{\alpha_t}} = 3.91$ rad^{-1}
$i_\omega = 1.0°$	

Reference geometry: $S = 184$ m^2, $S_H = 43$ m^2 $= S_t$, $b = 33.4$ m, $\ell_t = 16$ m, $\bar{c} = 5.7$m, $\eta = 1$. **(10 Marks)**

2 a. Derive an expression for Elevator angle to Trim and with the help of pitching moment curves. How Elevator angle to Trim can be obtained? **(10 Marks)**

b. Explain the effect of Elevator required for landing and restriction of forward limit of C.G. Range. **(10 Marks)**

3 a. With a help of diagram and expression, explain the control surface floating characteristics and aerodynamic balance. **(10 Marks)**

b. Derive an expression for stick force gradients in Unaccelerated Flight and also obtain the expression for the slope of the stick force versus speed curve. **(10 Marks)**

4 a. Obtain an expression for Rudder Control Effectiveness. **(06 Marks)**

b. Explain the contribution of Aircraft components to directional stability. **(06 Marks)**

c. Obtain an expression for the stability contribution of the vertical tail with a free rudder. **(08 Marks)**

PART – B

5 a. Define Roll stability. **(04 Marks)**

b. For the following data of NAVION airplane, estimate the roll control power, $C_{\ell_{\delta a}}$. Assume that the wing and aileron geometry are as $b/2 = 16.7$ m, $\lambda = 0.54$, $c_r = 7.2$ m, $c_t = 3.9$ m, $y_1 = 11.1$ m, $y_2 = 16$ m, $S = 184$ m^2, $C_{L_{\alpha_\omega}} = 4.44$/rad, $\tau = 0.36$. Consider for a tapered wing the chord can be expressed as a function of y by the following relationship $C = C_r\left[1 + \left(\frac{\lambda - 1}{b/2}\right)y\right]$. **(08 Marks)**

c. Describe the coupling between rolling and yawing moments. **(08 Marks)**

6 a. Develop the equations of longitudinal motion for airplane pure pitching condition. **(12 Marks)**
b. Write short notes on orientation and position of the airplane. **(08 Marks)**

7 a. Obtain the derivatives due to the pitching velocity. **(10 Marks)**
b. Obtain the derivatives due to the Rolling Rate. **(10 Marks)**

8 Write short notes on the following:
a. Effect of wind shear
b. Flying qualities in pitch
c. Spiral, Rolling and Dutch roll mode
d. Roll-Pitch-Yaw Inertial Coupling **(20 Marks)**

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